Agglomeration Economies and the Future of Cities

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May 22, 2003

Prepared for the PEAP Conference
Rotman School of Management, University of Toronto

Abstract

This paper will deal with why cities are important to business. It will cover three issues. First, some of the fundamentals of business location decisions will be considered. In some cases, firms are attracted to clusters of firms in similar industries (i.e., the Silicon Valley). In others, diverse cities appear to prosper. Second, recent empirical research on the importance of cities in firm location decisions will be reviewed. This research will explore clustering, the importance of diversity, and the possible existence of "cultural" factors that influence both firm location and city growth. Third, the implications of the research for the future of cities will be discussed.

I. Introduction.

A. Big questions and small answers.

A professor in graduate school said that there are two kinds of professors (actually, he said "economists"): those who ask big questions and those who provide small answers. Although my research often involves the latter, in this paper, I will emphasize the former. Big questions (like why do firms find cities to be attractive locations?) are inherently more interesting than are small answers (depending for example on things like the properties of order statistics). The references at the end of the paper give lots of small answers. I think that research in this area is moving towards a big answer. But we are not there yet, as this paper shows.

It is useful to begin by asking some big questions.

B. Four big questions.

1. Why do industries cluster?

No one who reads the newspaper or a good business weekly will be surprised to learn that industries cluster. The most striking example of an industrial cluster is the so-called Silicon Valley. And it has many cousins: a Silicon Forest, a Silicon Desert, and so on. But although this is a striking example, it is not unique. Other industries cluster as well. For instance, North American carpet manufactures have been concentrated in Georgia. But there are no Silicon Mines in California, and there are no carpet trees in Georgia. Exactly why would these footloose industries have chosen to concentrate?

It is important to recognize that concentration is costly. Putting more business activity in a small area raises the cost of doing business there in many ways: commutes are longer and space is more costly to name just two. Thus, industry clustering must benefit businesses in some way that compensates them for the costs of concentrating.

2. Why have households and firms chosen to agglomerate?

There is a related question that is also worth asking: why should human beings have concentrated ourselves in cities? The degree of agglomeration is striking. Recent Census figures show that around 80% of Canadians live in cities using the "urban places" definition. And yet, cities occupy roughly 2% of Canada's land. The situation is similar in the U.S.

Asking why a software company would locate with many other software companies is related to asking why a software company would locate where there are many other companies outside of software. As I noted above, concentration is costly. Thus, there must be some benefit associated with city size to go along with the benefit that encourages industry clustering.

3. What is the evidence on agglomeration?

Although both cities and industry clusters are costly, they both certainly exist. In this paper, I will review some of my research on the agglomeration and clustering. I will make available to anyone who is interested a more complete bibliography on the subject.

4. What is the future of cities?

Cities are costly, as noted above. And there have been technological changes – relatively cheap air travel and telephone communication, the invention of the fax machine, and most notoriously the Internet – that have possibly made it less costly to locate away from concentrations. Thus, there has been speculation that cities will decline in importance. This is the biggest question of all. If this were a trend, it would pay all of us handsomely to know about it sooner rather than later. To rephrase the question: will cities die? As eager as you might be to get to this issue (and I am certainly eager to paper about it), it is necessary to work through the other two questions first.

II. Why do clustering and agglomeration occur?

A. Agglomeration economies.

Let me begin by considering the related question: why are there cities at all? This is an interesting big question, but, as usual, one that ultimately admits only small answers. One answer to this question is that agglomeration exists because firms enjoy internal economies of scale. Scale economies imply that the firm needs many workers; workers concentrate to economize on commuting; thus, there is an agglomeration. This answer is not completely satisfying, though, since it motivates only the existence of factory towns and not the diverse cities that we actually observe.

A more satisfying answer is to say that there are "agglomeration economies", external economies of scale that make firms more productive in large cities. This explains diverse cities. More productivity translates into better living standards and higher profits. Both employers and labor are drawn to urban areas, and an agglomeration arises. But, of course, to say that the source of agglomeration is the existence of agglomeration economies is the worst sort of nominalism. Although many people have studied the consequences of agglomeraton economies, they did not devote much energy to modelling the sources (microfoundations) of agglomeration economies. To really answer the big question requires a careful consideration of these sources. It is this task that has occupied me off an on for fifteen years, and on which I am still devoting a lot of time.

I should point out, before discussing the sources of agglomeration economies, that nominalism has made further inroads. Agglomeration economies have been divided into localization and urbanization economies, with the former internal to an industry, while the latter depend on city size. It is localization economies that are key to the existence of industry clusters.

B. The sources of agglomeration economies.

Here is where the small answers come in. There are many, many explanations of the sources of agglomeration economies and industry clustering. The first discussion of some of these is found in Marshall who described them in 1890. My list will, of course, be incomplete.

1. *Labor market pooling.*

The idea here is that in a thick market, firms will be better able to find workers with the specialized skills that they require. And vice versa. This motivates both large cities (all firms need specialized accountants) and industry clusters (dress designers need specialized buttonmakers).

2. *Input sharing.*

Many kinds of agglomeration economies can be characterized as arising from shared inputs. To be concrete, all firms in Vancouver can share the Vancouver airport. This characterization of geographic increasing returns is not surprising, but it has some important implications. First, it suggests that it is worth thinking about imperfect competition between cities. For instance, if a city develops its port, other cities may be deterred. Second, since there are increasing returns, it is necessary to create an organization that achieves them. I will return to this point shortly.

3. *Knowledge spillovers.*

My list would not be complete without some mention of technological spillovers. The idea here is that innovation is greater with concentration. The most famous example of this is the industry cluster called the Silicon Valley. But there is innovation in less glamorous industries as well. The concentration of the carpet industry in Georgia is associated with just one particular innovation (a stitch) devised by a quiltmaker.

4. *Risk minimization.*

The idea here is similar. Large cities are more productive in an expected value sense because the consequences of failure are less grave. Put another way, a smaller fraction of an investment's cost is sunk. This is because it is more likely that the asset will be well-matched with another user in the used asset market. Thus, putting up a high-rise in a large city is less risky in that if its tenants fail, finding others is possible.

5. Consumption.

If you ask a recent migrant why he or she has recently moved, a very common answer is: "I got a good job." That is what we have been talking about so far. But that is clearly not the only answer a recent migrant might give. Instead, the migrant might point to the opportunities for consumption that are available in large cities but are not in less populated places. Restaurants, music, arts: these are all instances of urban bright lights, and they reasons why some people may choose to live in large cities. This, in turn, is why their employers may decide that large cities make sense. It is impossible, after all, to run a business that makes use of highly educated labor if the highly educated do not want to live where the business has located.

6. Information.

My list would also be incomplete if I were to leave you with the impression that agglomeration occurs only because it is efficient. If investment is characterized by herding or cascades, it is possible that agglomeration occurs even when it is inefficient. This and other sources of agglomeration economies and many others are described in much more detail in Rosenthal and Strange (2003), a review of the literature.

C. Clustering.

It is not hard to see how these features can come together to produce an industry cluster. Let me focus on the case of the Silicon Valley. In the software industry, there is great need for specialized labor. My friends who work there are proud that they have been able to change jobs without changing parking lots. Thus, the development of a thick and

specialized labor market is clearly one of the benefits that the Silicon Valley offers to software firms. But it is not the only one. Software is also a technologically innovative industry. Almost all commentators believe that the close proximity of key players has been an important engine of the industries localization.

Other industries localize as well. And many of these industries are not high technology industries at all. The following is a list of the most "localized" industries in the United States. The numbers in the table are known as "locational Gini coefficients." That is a fancy name for a fairly simple statistic. All that is needed in order to interpret the numbers is that G ranges from 0 (no clustering at all) to .5 (all employment is clustered). See Krugman (1991) for a more complete characterization.

The following table shows values of G for various industries:

Table 1. Clustering.

Rank	SIC	Description	Gini	Main states
1	303	Reclaimed rubber	0.5	WY,WI,WV
2	313	Boot and shoe cut stock & findings	0.482845	ME,MO,MA
3	315	Leather gloves and mittens	0.48233	WI,NY,WY
4	222	Weaving mills, synthetics	0.476676	GA,SC,NC
5	237	Fur goods	0.468169	NY,WY, WI
6	223	Weaving and fimshing mills wool	0.451512	ME RI NH
7	221	Weaving mills, cotton	0.443084	SC,GA NC
8	319	Leather goods, nec	0.442542	TX,MA CA
9	227	Floor covering mills	0.432963	GA SC VA
10	228	Yarn and thread nulls	0.428421	NC,GA SC
49	371	Motor vehicles & equipment	0.302518	MI, OH, DE
59	381	Eng & scientific instruments	0.266791	DE AZ WA
78	332	Iron & steel foundries	0.22053	AL WI OH

Source: Krugman (1991).

The first point that is apparent from this table is that some of the industries that are usually thought of as exhibiting a strong tendency towards clustering are actually not at the top of the list. Iron and steel foundries rank 78th, while motor vehicle manufacturing ranks only 49th. The second point that the table makes is that clustering is not simply a

high-technology, Silicon Valley phenomenon. At the top of the list are reclaimed rubber, boot and shoe stock, and leather gloves. These are not typically mentioned as dynamic, high-technology industries. And yet they are highly localized.

D. Economic diversity.

I moved to Toronto from Vancouver. In Vancouver, a lot of people were at least a little jealous of cities that are dominated by industry clusters. Seattle is Vancouver's nearest large-city neighbor, and it has two strategic industries: airframe manufacturing and software. Thus, it is important for me to point out that there are successful cities that are not dominated by an industry cluster. And over the long run, it may be that diverse cities will outperform specialized cities.

Why might diversity be useful? One answer is statistical in nature. When a strategic industry declines, what can replace it? The severity of Vancouver's recessions when it was dominated by forestry underline the pitfalls of specialization.

Another reason that diversity might be useful is that diverse cities may be more adaptable than specialized ones. This point can be illustrated by the story of the founding of futures markets in Chicago. Originally, Chicago's primary activity was as a transshipment point for grain. The grain had to be stored, and so grain silos were built. Originally, a farmer would put grain in the silo and get back exactly the same bag of wheat. But this is inefficient, requiring each farmer to pay for an entire storage area in a silo. So this was replaced with a system where the farmer's grain was graded, and the farmer received a receipt for some grain of the appropriate type, but he or she had no entitlement to exactly the same grain. But once this system was in place, it was possible to trade the receipts, and from this the step to an organized futures market was a natural one. But natural as it was, it was not a step that Chicago's 19th Century residents were likely to have foreseen. All of this underscores the idea that cities are dynamic, and that multifaceted cities might be more adaptable than monolithic ones.

At this point, I believe it is useful to look at some fairly scientific evidence of the tendency of industries to cluster and of the importance of agglomeration.

III. Evidence.

A. Overview.

The measurement of agglomeration economies fits into the grand tradition of finding a residual and attributing its source in a convenient fashion. In searching for the sources of economic growth, economists have attributed much of it to the accumulation of human and physical capital. But there is a leftover, and this has been named technological progress.

The measurement of agglomeration economies has taken a similar approach. Thus, for example, the determinants of urban wages have been measured. Much of this can be attributed to the usual suspects, capital and so forth. But again there is a leftover. And if the leftover is correlated with city size it is labeled an urbanization economy. If it is correlated with industry size, it is a localization economy. If it is correlated with the past, it is a dynamic agglomeration economy.

The consensus of these papers is that a doubling of city size leads to a 4-5% increase in productivity. There is also evidence that agglomeration economies tend to be internal to the industry (localization economies) and long lasting (dynamic).

B. Recent evidence.

I have carried out some work on this subject myself (Rosenthal and Strange (2003)). At this point, I will briefly discuss a table from the paper. If you are really curious about these issues, you may want to look up the paper.

TABLE 2
NEW-ESTABLISHMENT EMPLOYMENT
(Numbers in Parentheses are t-ratios)

	Software SIC 7371-73, 75	Food Products SIC 20	Apparel SIC 23	Printing & Publishing SIC 27	Fabricated Metal SIC 34	Machinery SIC 35
	Zipcode Area, Diversity, and Competition Effects					
Zipcode Herfindahl Index	-2.208E+02 (-34.372)	-2.085E+02 (-16.419)	-9.332E+02 (-15.692)	-3.239E+02 (-31.236)	-1.189E+02 (-19.28)	-1.147E+02 (-26.216)
Zipcode firms per worker - other ind.	-2.204E+02 (-22.926)	-2.071E+02 (-12.37)	-6.910E+02 (-8.738)	-3.144E+02 (-20.267)	-1.435E+02 (-15.893)	-1.200E+02 (-19.577)
Zipcode firms per worker - own ind.	3.188E+01 (12.615)	2.275E+01 (4.700)	1.602E+02 (8.159)	2.718E+01 (6.094)	3.986E+00 (1.603)	-1.316E+00 (-0.716)
	Urbanization Effects: Other (Total - Own) Industry Employment In The ...					
0 to 1 Mile Ring	-7.830E-05 (-3.606)	-7.760E-05 (-2.424)	-1.241E-04 (-0.723)	2.538E-04 (4.383)	-4.800E-05 (-2.344)	-1.500E-05 (-0.995)
1 to 5 Mile Ring	2.610E-05 (4.510)	1.670E-06 (0.177)	2.549E-04 (4.088)	3.630E-05 (1.807)	-1.400E-05 (-2.505)	-7.450E-06 (-1.777)
5 to 10 Mile Ring	-1.030E-05 (-2.52)	6.230E-06 0.930	4.810E-05 (1.016)	5.390E-05 (3.805)	-4.550E-06 (-1.203)	-1.790E-06 (-0.69)
10 to 15 Mile Ring	4.070E-06 (1.156)	2.120E-06 (0.3140)	8.220E-05 -(1.9030)	1.500E-05 (1.184)	4.510E-06 (1.264)	-2.690E-07 (-0.124)
	Localization Effects: Own Industry Employment In The ...					
0 to 1 Mile Ring	1.171E-02 (10.385)	1.245E-02 6.272	4.034E-03 (1.061)	-1.346E-03 (-1.433)	6.613E-03 4.602	3.802E-03 (6.738)
1 to 5 Mile Ring	8.574E-04 (2.895)	2.945E-03 4.032	-5.261E-04 (-0.288)	-5.659E-04 (-1.458)	2.689E-03 6.368	6.897E-04 (3.973)
5 to 10 Mile Ring	8.545E-04 (4.110)	-5.531E-04 (-1.015)	-3.604E-04 (-0.242)	-9.037E-04 (-3.086)	4.750E-04 1.647	-9.560E-06 (-0.081)
10 to 15 Mile Ring	-1.215E-04 (-0.63)	6.180E-05 (0.115)	-2.819E-03 (-1.838)	-3.661E-04 (-1.32)	-3.765E-04 (1.480)	2.666E-04 (2.637)
	Average Change In Localization Effect Per Mile From ...*					
0.5 to 3 Miles	-4.34E-03	-3.80E-03	-1.82E-03	3.12E-04	-1.57E-03	-1.24E-03
3 to 7.5 Miles	-6.44E-07	-7.77E-04	3.68E-05	-7.51E-05	-4.92E-04	-1.55E-04
7.5 to 12.5 Miles	-1.95E-04	1.23E-04	-4.92E-04	1.08E-04	-1.70E-04	5.52E-05
	Summary Measures					
Stnd Error	58.17	60.76	346.65	87.44	36.26	30.78
Log-L	-39,825.85	-9,963.03	-14,809.64	-34,435.40	-12,710.56	-20,398.02
$2(LogL - LogL_{NoFE})$**	1,703.27	648.03	618.00	1,105.36	552.54	714.70
Uncensored	6,362	1,324	1,639	5,006	1,875	3,280
Total Obs	39,068	39,068	39,068	39,068	39,068	39,068
Fixed Effects	373	373	373	373	373	373

*Change per mile is computed by differencing the adjacent localization coefficients and dividing by the number of miles between the midpoints.

**The test statistic $2(LogL - LogL_{NoFE})$ is distributed Chi-square with 372 degrees of freedom, where $LogL_{NoFE}$ is the value of the log-likelihood function when the fixed effects are omitted but a constant is retained.

Table 2 looks at firm births in six industries. The variables that are most interesting are the geographic ones. By using geocoding sofware, we were able to identify the amount of employment not just in a firm's immediate area (zipcode). We were also able to identify the amount of employment within two to five miles, six to ten miles, and so on. The theory that I have been discussing suggests that if there are similar firms nearby, new firms should find the area to be more attractive. But the theory does not say what "nearby" might mean. Our table, however, does. There is a very clear pattern. The coefficient of own industry employment ("localization") at two to five miles is roughly one third the size of the coefficient in the same zipcode. Thus, the forces that give rise to clustering are present. And they are also highly localized. Our results suggest strongly that firms must be quite close in order to benefit from each other's presence. And this is true even in the software industry, where presumably everyone has access to email, and so distance should not matter at all.

I would like to point out that our estimates also establish that diverse locations (low values of "herf") are more attractive to new firms than are specialized ones. This is consistent with the increasingly popular view that the benefits of clustering have limits. It is also consistent with a few often attributed to Jane Jacobs that the benefits of cities are largely serendipitous.

Let me conclude this part of the paper by noting one more conclusion that this research has reached. It appears that small firms and nonsubsidiary firms have a greater positive effect on their neighbors than do large firms and subsidiaries. There are many potential explanations for this finding, and I should probably not speculate. But I cannot resist. One interpretation of these results is that an entrepreneurial business environment is more productive than a hierarchical environment. This certainly appears to be the case in the Silicon Valley. In the mid-1980s, both the Route 128 corridor in Boston and the Silicon Valley appeared to be comparable as centers of high-technology. In the intervening years, the Silicon Valley has prospered, while Route 128 has not. Why? There are many explanations. Saxenian (1994) has proposed that the difference in business culture is key. Route 128 is hierarchical, dominated by large corporations. The Silicon Valley is entrepreneurial, continually refreshed by startups. She argues that it is the culture of

flexibility that has been the key to the divergence between the two centers of high-technology.

The research that I have been discussing is consistent with this view. Specifically, as Table 3 shows, the effects of additional employment are larger if the employment is at a smaller firm.

TABLE 3
LOCALIZATION EFFECTS CONTROLLING FOR ESTABLISHMENT SIZE
(Numbers in Parentheses are t-ratios)

	Software SIC 7371-73, 75	Food Products SIC 20	Apparel SIC 23	Printing & Publishing SIC 27	Fabricated Metal SIC 34	Machinery SIC 35
	BIRTHS OF NEW ESTABLISHMENTS					
Employment at:						
Small firms	1.76E-03	1.29E-03	-5.74E-04	4.15E-04	1.66E-04	2.80E-04
(1-24 workers)	(10.733)	(4.155)	(-1.303)	(4.365)	(2.754)	(5.544)
Medium firms	-6.58E-04	9.58E-06	-1.92E-04	-3.41E-04	4.30E-05	-2.49E-05
(25-99 workers)	(-4.453)	(0.083)	(-0.601)	(-4.164)	(1.409)	(-0.674)
Large Firms	4.84E-05	1.96E-05	6.09E-04	-5.33E-07	3.31E-06	4.40E-06
(100+ workers)	(3.502)	(1.396)	(3.589)	(-0.049)	(0.504)	(1.267)
	NEW-ESTABLISHMENT EMPLOYMENT					
Employment at:						
Small firms	2.48E-02	3.76E-02	-6.85E-02	1.81E-02	1.65E-02	1.23E-02
(1-24 workers)	(6.614)	(1.957)	(-2.551)	(3.163)	(2.901)	(4.463)
Medium firms	6.88E-04	1.52E-02	4.17E-02	-1.48E-02	7.74E-04	6.53E-04
(25-99 workers)	(0.205)	(2.162)	(2.539)	(-3.017)	(0.275)	(0.326)
Large Firms	7.97E-04	1.88E-03	-3.52E-03	-1.68E-04	2.35E-03	1.67E-04
(100+ workers)	(2.519)	(2.212)	(-0.405)	(-0.254)	(4.161)	(0.881)

*The estimates above are the coefficients on the localization variable for the indicated employment type having summed the localization concentric ring variables out to 5 miles and omitted the remaining localization concentric rings (miles 6 to 15). All other variables listed in Table 2 were included in the model: coefficients for those variables are not reported to conserve space.

IV. The Future of Cities.

A. Will cities die?

This is a big question indeed. Business gurus win converts by telling the following kinds of stories: everything is changing – the economy has globalized, while the telephone, air travel, and the Internet allow people and firms to interact across great distances – and this means that the world twenty years from now will look very different than it does now. Some urbanists suggest that the different world will feature far fewer large cities.

There are certainly reasons to believe that this might occur. It is undeniably costly to live in a city. If it is simple to ship car parts from Mexico to Ontario, why should automobile manufacturers cluster? And a software producer can easily communicate using the Internet, so why should it feel the need to locate in a large city?

B. Reports of the death of cities have been grossly exaggerated.

Consider the supposed effect of the Internet. It has been argued that it is now easy to have instant and reliable communication with someone else halfway across the world. Won't this remove the value of concentrating business in cities?

Let me answer this question by asking another. To whom did you send your last email? Or make your last phone call? For most of us, it will be someone with whom we have had face-to-face contact. Why? Because there is no substitute yet for face-to-face contact in building a relationship. And this face-to-face contact is much easier for workers at firms that are quite close to each other. And this means that not only are cities unlikely to die, neither are downtowns.

What are the facts? First, cities continue to grow and this growth is expected to persist. In 1950, there were just two cities with populations of more than 10 million (London and New York). In 1994, there were 14. In 2015, there are projected to be 27. Second, cities continue to have higher productivity than the national economies that contain them.

Paris, for example, is thought to be 35% more productive than the rest of the French economy (The Economist, 1995). Finally, the desire for concentration persists, even in those industries like computers where one might think that modern alternatives to face-to-face contact would be most useful.

C. Conclusion.

Let me conclude by presenting some simple and seductive ideas that I guarantee you will encounter in the popular media. And then let me try to convince you that I have shown these ideas to be at best misleading and at worst completely wrong:

- *Globalization means that anything can take place anywhere. Distance used to matter, but it doesn't anymore.*

In fact, both clustering and urbanization are continuing.

- *Thus, cities (with their associated congestion and pollution) are old economy institutions. The new economy will grow outside of cities.*

This would require the creation of substitutes for face-to-face interaction. Maybe such substitutes are here already or will be soon. But I don't think this is obvious yet. And as of now, the new technologies seem to be complements to face-to-face interaction rather than substitutes.

- *High-technology industries are the ones that tend to cluster in order to facilitate learning.*

Many other industries cluster, and there are many good reasons for them to do so.

In sum, there are a lot of misleading and incorrect ideas in circulation regarding business location, clustering, and the future of cities. If this paper has accomplished anything, I hope it is to make you sceptical about some of these fashionable canards.

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